Dd-14558

Beckman Industrial™

An Affiliate of Emerson Electric Co.

Control Number
DVEML0218

Heavy Duty Digital Multimeters

Models 100, 110, 110T, and 130B

Operator's Manual

CRT Service Safety Reminder

A POTENTIAL DANGER TO YOU AND YOUR METER EXISTS WHEN MEASURING VOLTAGES IN THE HORIZONTAL OUTPUT AND DAMPER STAGES OF CRT EQUIPMENT. THIS DANGER IS CAUSED BY THE HIGH VOLTAGE TRANSIENTS (GREATER THAN 6,000 VOLTS) THAT OCCUR IN THESE CIRCUITS. PLEASE REFER TO YOUR CRT SERVICE MANUAL FOR PROPER SERVICING INSTRUCTIONS.

Heavy Duty Series Digital Multimeters

(HD100, HD110, HD110T & HD130B)

Operator's Manual

Beckman Industrial Corporation
Instrumentation Products Division
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Warranty

One Year Limited Warranty

Heavy Duty Series Digital Multimeters are warranted against any defects of material or workmanship within a period of one (1) year following the date of purchase of the multimeter by the original purchaser. This warranty is extended by Beckman Industrial Corporation (manufacturer), only to the original purchaser or original user of the multimeter.

In the USA any multimeter claimed to be defective during the warranty period should be returned to Beckman Industrial's Factory Service Center with a $3 handling fee. Repair is typically made within two working days. Follow the shipping instructions on page 32 and in Section VII. For warranty repair outside the USA contact your local Beckman Industrial dealer or distributor where your multimeter was purchased, or return it to Beckman Industrial's Factory Service Center with a $12 handling fee. Refer to Section VII for the appropriate address.

In event of replacement with a new or reconditioned model, the replacement unit will continue the warranty period of the original multimeter.

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Beckman Industrial Corp.

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Section I Introduction

Series 100 Heavy Duty Digital Multimeters are portable, rugged, hand-held 3½-digit multimeters designed for the engineer, technician, or hobbyist who demands an accurate, reliable, durable instrument that is always ready for use. Equipped with seven functions and 29 ranges, each test position is selected by simply turning the selector switch. Small enough to fit in most attaché cases and equipped with a multiposition tilt stand, these instruments are equally suited for design and engineering, production testing, field servicing, and industrial maintenance applications.

Additionally, the Heavy Duty Series offers two uncommon, yet particularly useful features. With Insta-Ohms, circuit shorts can be traced and other continuity checks can be made more quickly and easily than ever before with a digital multimeter! It also can be used for troubleshooting small-value capacitors. The heavy duty case is tough—to sustain accidental drops and is sealed with O-rings to exclude dirt, oil, and water.

Standard Features

All of the following features are standard for the Heavy Duty Series:

Superior Reliability

To ensure reliability, Beckman Industrial designed a custom CMOS large-scale integrated circuit to eliminate most components. All active multimeter functions are performed by this integrated circuit, reducing the number of parts in each instrument. Reliability is also enhanced by 100% burn-in of each multimeter and complete factory test of every function and range.

Guaranteed Long-Term Accuracy

Specified accuracies are guaranteed for one (1) full year. Long-term accuracy is assured by the use of an extremely stable band-gap reference element and precision thin-film resistor networks.

Ruggedness

Heavy Duty Series Multimeters are designed for years of trouble-free operation under heavy duty use. The instruments can take accidental falls and come up working—and still meet specified accuracies. The display and single rotary switch are recessed and sealed to prevent damage while in a tool box or on the job. The case is designed to keep out dirt, dust, liquids, and other contaminants that can cause malfunctions in other multimeters.

Waterproof

The meter case has been totally O-ring sealed, including the range selection knob and the four screws that access the circuitry. The display window is gasketed and ultrasonically sealed in the case for a tight, waterproof seal. The input terminal jacks are O-ring sealed and water-tight.

Overload Protection

All inputs are protected against continuous overload conditions that may result from the measurement of unknown signals or from operator error. Current ranges are protected by 600V fuses of either 2 amp or 15 amp rating. The ten amp current input is protected to a fault limit of 100,000 amperes when the factory recommended fuse is installed.

Ease of Use

Human engineered in every way to make the instruments easy to use, a single switch turns on power, and selects both function and the desired range. The liquid-crystal display (LCD) is easy to read both indoors and outdoors - even in direct sunlight.

In-Circuit Resistance Measurements

All resistance ranges are low-power ohms which allow accurate measurements on in-circuit resistance. Because test voltages are held to less than 250mV, accurate measurements may be made even in circuits where resistors are directly shunted by typical silicon diodes and transistors.

Diode Test Function

A special diode test function allows accurate measurements of forward voltage drops across diodes and transistor junction, even in circuits where semiconductors are shunted directly by resistors.

Battery Life

One standard 9-volt transistor battery provides up to 2,000 hours of continuous instrument operation. Under typical use, a battery should last two years.

Low Battery Indicator

The decimal point begins to blink when approximately 200 hours of battery life remains.

Versatility

Perfect for field, lab, or home use. Small, lightweight, and completely portable. It has a handy tilt bail for easy positioning and antiskid pads to keep it in place.

Complete and Ready for Use

Instruments are shipped with battery and fuse installed, ready to use. Also, included with each instrument is a spare 2 amp fuse, TL-245 Probe Set.

Special Features

HD100

The HD100 has the features described previously, excluding the Insta-Ohms Quick Continuity test function and ten ampere current ranges. It has an accuracy of ±0.25% of reading in DC volts.

HD110

The HD110 has all of the features of the HD100 plus the Insta-Ohms Quick Continuity test function, audible continuity indicator, and ten ampere current ranges. It has an accuracy of ± 0.25% of reading in DC volts.

HD110T

The HD110T has all the standard features and performance of the HD110, except the audible continuity beeper. In addition, the HD110T offers a built-in temperature measurement function which uses a standard type K Thermocouple to read temperature in either Fahrenheit or Celsius. It has an accuracy of ± 0.25% of reading in DC volts.

HD130B

The HD130B has all the features of the HD100 plus the Insta-Ohms Quick Continuity test function, audible continuity indicator, and ten ampere current ranges. It has an accuracy of ± 0.1% of reading in DC volts and the capability of measuring the True RMS value of AC voltage and current.

NOTE

The symbol on the front panel of the multimeter is an international symbol meaning "REFER TO OPERATING INTRUCTIONS." Warnings and precautions to avoid personal injury and multimeter damage are listed in Section IV.

WARNING

High voltages can be lethal. Use extreme caution when working with and measuring high-voltage sources. High voltage transients may occur in nearly all defective electronic equipment

Section II Specifications

Specifications are subject to change without notice.

General Specifications

The following specifications apply to the Heavy Duty Series Digital Multimeters.

Operating Temperature Range
0°C to +50°C

Storage Temperature Range
-40°C to +65°C with battery removed

Display
Shock protected 3½ -digit liquid-crystal display (LCD) with a maximum reading of 1999.

Power
Single, standard 9-volt transistor battery, NEDA 1604

Battery Life
Alkaline: 2,000 continuous hours, nominal.
Zinc-Carbon: 1,600 continuous hours, nominal.
Under typical usage, two years.

Low Battery Indicator
Decimal point blinks when 200 hours battery life remain.

Shock and Vibration
Meets MIL-T28800 Class II Type A Specifications.

Relative Humidity
0% to 80%, 0°C to 35°C; 0% to 70%, 35°C to 50°C.

Temperature Coefficient
0°C to 20°C, 30° to 50°C

Maximum Common Mode Voltage
1500VDC or peak AC.

Dimensions
7.0 inches (17.8 cm) long x 3.9 inches (9.9 cm) wide x 2.0 inches (5.1 cm) high.

Weight
19 ounces (543 gm) including battery.

Calibration
Accuracy specifications guaranteed for one (1) year, 20° C to 30° C.

Measurement Rate
Four measurements per second nominal.

Case
Specially reinforced high-impact, fire-retardant plastic, recessed switch and display.

Included with Instrument:
1. Nine-volt battery
2. Spare 2 amp fuse
3. TL-245 Probe Set
4. Operator's manual

DC Volts

General
Automatic polarity indication (+ and - indicated)

		ACCURACY (1 YEAR, 20°C to 30° C)	
RANGE	RESOLUTION	HD100, HD110 HD110T	HD 130B
±200mV	100µV	+ (0.25% reading	±(0.1% reading
±2V	1mV	+ 1 digit)	+ 1 digit)
±20V	10mV		
±200V	0.1V		
±1500V	1V		

Input Impedance (all ranges)
22MΩ

Normal Mode Rejection
Greater than 60dB above 49Hz.

Common Mode Rejection
Greater than 60dB above 49Hz.

Response Time
Less than one second.

Overvoltage Protection
1500VDC or peak AC, any range

AC Volts

Thsee specifications apply to the HD100, HD110, and HD110T. Accuracies apply to sine wave inputs only and for RMS with crest factors less than or equal to 1.5.

		ACCURACY (1 year, 20°C to 30°C)		
RANGE	RESO-LUTION	45Hz to 2kHz	2kHz to 5kHz	HD130B only 5kHz to 10kHz
200mV	100µV			
2V	1mV	±(0.75%	±(1.5%	±(2.5%
20V	10mV	reading + 3	reading +5	reading +9
200V	0.1V	digits)	digits)	digits)
1000V	1V			

Conversion Technique
Average sensing, calibrated to display RMS value of sine wave.

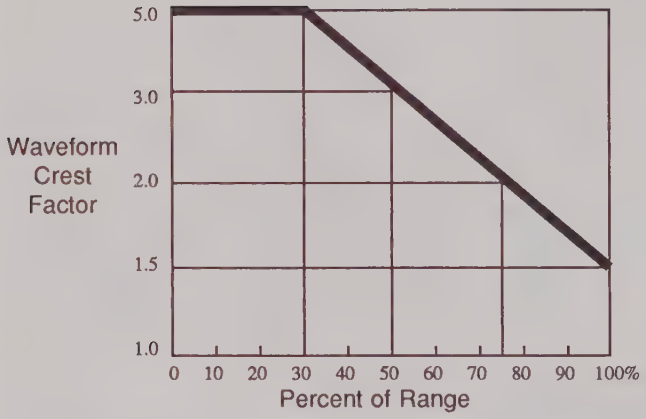
Input Impedance (all ranges)
2.2MΩ, shunted by less than 75pF

Response Time
Less than two seconds

Maximum Input Voltage
1000VRMS AC(1500V peak) or 250VDC (5 sec maximum above 450VRMS on 20mV range)

The following specifications apply to the HD130B.

		ACCURACY (1 YEAR, 20°C TO 30°C)				
RANGE	RESO-LUTION	45Hz to 2kHZ	2kHz to 5kHz	5kHz to 10kHz	10kHz to 20kHz	20kHz to 40kHz
200mV	100µV	±(0.6%	±(1.0%	±(1.5%	±(2.5%	±(5%
2V	lmV	reading	reading	reading	reading	reading
20V	10mV	+3	+4	+5	+7	+16
		digits)	digits)	digits)	digits)	digits)
200V	0.1V	±(0.6%	±(1.0%	±(1.5%	±(2.5%	
1000V	1V	reading +3 digits)	reading +4 digits)	reading +5 digits)	reading +7 digits)	Not Specified



Crest Factor (HD 130B)
Allowable crest factor (peak/RMS ratio) varies from 1.0 to 5.0.

Conversion Technique (HD 130B)
True RMS responding (AC coupled)

Input Impedance (all ranges)
2.2 megohms, shunted by less than 75pF

Response Time
Less than two seconds (on HD130B, above 10% of full-scale)

Overvoltage Protection
HD100, HD110, HD110T,; 1000VRMS AC (1500V peak) or 250VDC (five seconds maximum above 450VRMS on 200mV range)
HD130B; 1000VRMS AC (1500V peak) or 1500VDC (200mV range, 500VRMS or DC max.)

DC Current

Range	Resolution	Accuracy (1 Year, 20°C to 30°C) HD100, HD110 HD110T	HD130B
±200µA ±2mA ±20mA ±200mA ±2A	100nA 1µA 10µA 100µA 1mA	±(0.75% reading + 1 digit)	±(0.35% reading + 1 digit)
±10A*	10mA	±(1.5% reading + 1 digit)	±(1.0% reading + 1 digit)

*Not applicable to HD100.

General
Automatic polarity indication (+ and - indicated)

Response Time
Less than one second

Voltage Burden
200µA to 200mA ranges: 250mV maximum at full-scale
2A range: 700mV maximum at full-scale
10A range: 600mV maximum at full-scale

Overcurrent Protection - A Input
Two amperes, 600V (fused)

Overcurrent Protection - 10A Input
15 amperes, 600V (fused)
100,000 ampere interrupt
(input is rated up to 20 amperes for 30 seconds)
(Not applicable to HD100)

AC Current

		Accuracy (1 Year, 20°C to 30°C)				
		45Hz to 400Hz		400Hz to 2kHz		2kHz to 5kHz
Range	Resolution	HD100 HD110 HD110T	HD130B	HD100 HD110 HD110T	HD130B	HD130B
20µA 2mA 20mA 200mA	100nA 1µA 10µA 100µA	±(1.5% reading +3 digits)	±(0.9% reading +3 digits)	±(1.5% reading +3 digits)	±(0.9% reading +3 digits)	±(1.5% reading +3 digits)
2A	1mA	±(1.5% reading +3 digits)	±(0.9% reading +3 digits)	±(1.5% reading +3 digits)	±(0.9% reading +3 digits)	
10A*	10mA	±(2.0% reading +3 digits)	±(1.5% reading +3 digits)			

*Not applicable to HD100

Crest Factor (HD130B)
1.0 to 5.0 (Refer to graph on page 8.)

Conversion Technique
Averaging Models: Average sensing, calibrated to display RMS value of sine wave.
HD 130B: True-RMS responding (AC coupled)

Response Time
Less than two seconds (on HD130B, above 10% of full-scale)

Voltage Burden
200µA to 200 mA ranges: 250mV maximum at full-scale
2A range: 700mV maximum at full-scale
10A range: 600mV maximum at full-scale

Overcurrent Protection - A Input
Two amperes, 600V (fused)
100,000 ampere interrupt
(input is rated up to 20 amperes for 30 seconds)
(Not applicable to HD100)

Resistance

The following specifications apply to the Heavy Duty Series, unless otherwise indicated.

RANGE	RESOLUTION	MAX. TEST CURRENT	ACCURACY (20°C to 30°C) HD100, HD110, HD110T	ACCURACY (20°C to 30°C) HD130B
200Ω 2kΩ 20kΩ 200kΩ 2MΩ	0.1Ω 1Ω 10Ω 100Ω 1000Ω	2.5mA 250µA 25µA 2.5µA 250nA	±(0.5% reading + 1 digit)	±(0.2% reading + 1 digit)
20MΩ	10kΩ	25nA	±(1.5% reading + 1 digit)	±(1.0% reading +1 digit)

General

Low-power ohms on all ranges

Maximum Open Circuit Voltage

0.5V all ranges

Maximum In Range Voltage (low power ohms)

250mV, all ranges

Response Time

Less than one second, except 20MΩ range, less than four seconds

Overload Protection

600VDC or RMS AC, any range

Diode Test

Range
0V to 2V

Resolution
1mV

Accuracy
HD100, HD110, HD110T: ±(0.25% reading plus two digits)
HD130B: ±(0.1% reading plus two digits)

Accuracy Conditions
One year, 20°C to 30°C

Test Current
2mA, ±20%

Response Time
Less than one second

Overload Protection
600VDC or RMS AC

Temperature (HD110T Only)

Factory Set Mode
Fahrenheit

Ranges
-20°C to 1260°C
-4°F to 1999°F

Resolution
1°C or °F

Accuracy
(at 25°C ±5°C ambient)

RANGE	ACCURACY
-20°C to -1°C	±4°C
0°C to 300°C	±3°C
301°C to 400°C	±1% of Reading ±2°C
401°C to 600°C	±2% of Reading ±3°C
601°C to 1260°C	±3% of Reading
-4°F to 31°F	±6°F
32°F to 572°F	±5°F
573°F to 800°F	± 1% of Reading ±2°F
801°F to 1000°F	± 2% of Reading
1001°F to 1999°F	± 3% of Reading

Thermocouple Type
Type K

Input Connector
Miniature or subminiature

Insta-Ohms® Quick Continuity Indicator

Response Time
Less than 100 milliseconds
(Model HD110): Insta-Ohms Continuity Indicator initiates a single audible tone burst of approximately 3500Hz concurrent with the Insta-Ohms display.

Section III Preparation for Use

This section describes the following: unpacking and inspection, installation, controls, indicators, connectors, and initial checkout procedure.

Unpacking and Inspection

Remove the multimeter from the shipping container. The box should contain the following:

1. Multimeter
2. TL-245 Probe Set (one black, one red)
3. Nine-volt battery (installed)
4. Two 2 ampere fuses (one installed and one spare inside the case) and one 15 ampere fuse (installed, all except HD100). To gain access to inside of instrument, see Section V.

Account for and inspect all of these items. If any of the items are damaged or missing, immediately return the complete package to the place of purchase for an exchange.

NOTE

Retain the shipping container for use if instrument must be returned for exchange or repair.

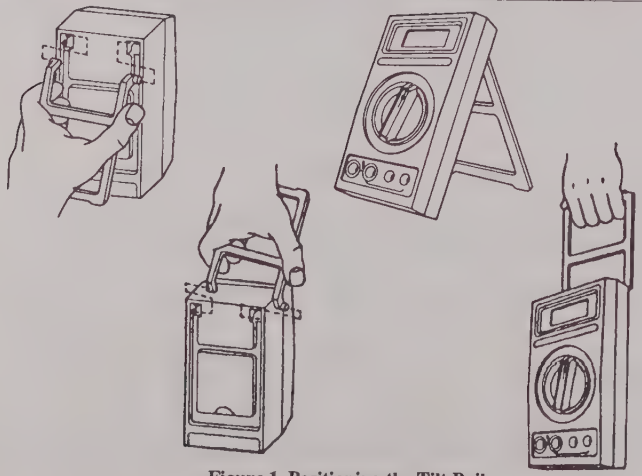


Figure 1. Positioning the Tilt Bail

Installation

The multimeter is shipped ready for use. The only action required by the user is to place the tilt bail in the desired position. Figure 1 shows the positions that the tilt bail may be placed in. The tilt bail is moved from one position to another by squeezing the two sides of the bail together and then reinserting the tips in the desired positions.

Multimeter Familiarization

We STRONGLY RECOMMEND that the user become familiar with the controls, indicators, and connectors of the Multimeter, shown and described in Figure 2, before operating the device.

1. Digital Display—A shock-mounted 3½-digit LCD readout (max. reading 1999) with automatic decimal point placement, automatic polarity indication, overrange indication, low battery indication (blinking decimal point), and the Insta-Ohm Quick Continuity Indicator (Ω) indicates measured input value in volts, amperes, or ohms as selected by the Function/Range Switch.

2. Function/Range Switch—This switch turns the instrument off and on and selects the function and range. Six functions can be selected by directing the pointer on the center bar to: VDC, VAC, DCA, ACA, Ω(ohms), or Diode Test. The VDC function provides five ranges from 200mVDC to 1500VDC. The VAC function provides five ranges from 200mV to 1000VRMS AC. The DCA and ACA functions each provide five ranges of current measurements from 200μA to 2A full-scale on the HD100, and six ranges of current measurements from 200μA to 10A full-scale on the HD110, HD110T, and HD130B.

3. Diode Test Function—Used for checking diodes and other semiconductor junctions.

4. A Input Connector (White)—Banana jack connector for current measurements up to 2 amps. The multimeter is protected by a fuse against inputs over 2 amperes.

5. COM Input Connector (Black)—Banana jack connector used as the common or low input for all measurements.

6. V-Ω Input Connector (Red)—Banana jack connector used as the high input for all voltage and resistance measurements.

7. 10A Input Connector (White), HD110, HD110T, and HD130B only—Banana jack connector used for current measurements up to 10A. The multimeter is protected by a fuse against inputs over 10 amperes.

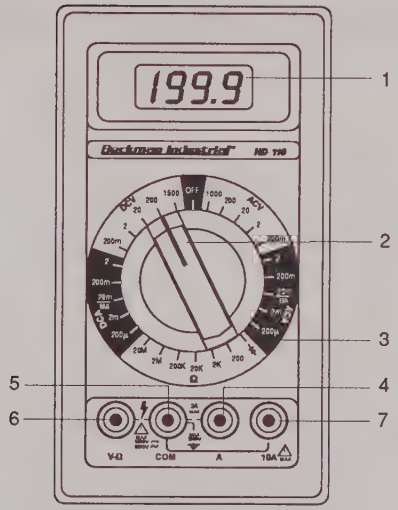


Figure 2: Operating Controls, Indicators and Connections

Initial Checkout

Before placing the Multimeter into use, a simple checkout procedure will ensure that the device is working properly. The only equipment required is the test leads.

1. Be certain that battery and fuse are installed properly, see Section V.
2. Connect the red test lead to the V-Ω Input Connector and the black test lead to the COM Input Connector.
3. Place the Function/Range Switch in the 1500VDC position.
4. Touch the red test lead and black test lead together. Observe the Digital Display; it should read 000 ±1.
5. Turn the Function/Range Switch counterclockwise to each DCV position while observing the Digital Display. With the test lead tips in contact, the Digital Display should read zero plus or minus one digit and the decimal point positioned as follows:

200V	00.0
20V	0.00
2V	.000
200mV	00.0

6. Turn the Function/Range Switch to the 20MΩ position. With the two test lead tips separated, the Digital Display should read OL (overload).
7. Touch the test lead tips together and observe the Digital Display; it should read 0.00 or 0.01.
8. Turn the Function/Range Switch to each Ω position while observing the Digital Display. With the test lead tips in contact, the Digital Display should read 0 in each position. In the 200Ω position, the Digital Display may read 00.1 or 00.2 because of test lead resistance. The decimal point should be positioned as follows:

20MΩ	0.00	20kΩ	0.00
2MΩ	.000	2kΩ	.000
200kΩ	00.0	200Ω	00.0

9. Turn the Function/Range Switch to the 1000VAC position.

WARNING

The next step requires the measurement of the standard 120VAC household voltage. Be careful not to touch the test lead tips with fingers and do not allow the tips to contact each other.

10. Measure the household voltage at a convenient AC wall socket. The Digital Display should show the appropriate voltage with a resolution of one volt.
11. Remove both probes from the AC wall socket.
12. If the instrument has performed properly during this checkout procedure, it is fully operational and ready to use.

Section IV Operating Instructions

This section of the manual describes the various operating modes on the Multimeter as well as a summary of warning and precautions.

Warnings and Precautions

The following warnings and precautions are mentioned to protect the user from injury and the instrument from damage.

Warnings

1. Do not attempt to measure voltages or currents that may exceed the ratings marked on the Function/Range Switch or terminal overlays.
2. Use extreme caution when working near high voltage sources. This includes any voltage measurements requiring the use of the two highest VAC or VDC ranges.
3. To avoid electrical shock hazard and/or damage to the multimeter, do not measure voltages that might exceed the maximum voltage rating above earth ground.
4. Operator injury or damage to the multimeter may occur during current measurements if the fuse blows in a circuit which exhibits an open circuit voltage greater than 600 volts.
5. Before each use of the multimeter, inspect test leads, connectors, and probes for cracks, breaks, or crazes in the insulation. If any defects are found, replace item immediately.
6. To avoid electrical shock hazard, do not touch test leads, tips, or the circuit being tested while power is applied to the circuit being measured.

Precautions

1. Exceeding the maximum input overload limits can damage the multimeter.
2. When measuring current, check that the multimeter is connected in series with the load in which the current is to be measured. NEVER connect the multimeter ACROSS a voltage source. To do so can result in either blowing the overload protection fuse or damaging the device being tested.
3. Always remove the temperature probe from the HD110T before using any other functions.

Overload Indication

The multimeters are equipped with automatic overload indication. This means that whenever an input signal is larger than the range selected, an overload symbol (OL) will appear in the Digital Display, see Figure 6. This feature allows the user to test devices with unknown circuitry where an overload condition might exist but would not exceed the capability of the multimeter.

Voltage Measurements

DC Voltage

1. Connect red test lead to V-Ω Input Connector and black test lead to COM Input Connector.
2. Set Function/Range Switch to desired DCV position. If magnitude of voltage is not known, set switch to highest range and reduce until satisfactory reading is obtained.
3. Turn off power to device or circuit being tested and discharge all capacitors.

> **WARNING**
> To avoid electrical shock hazard and/or damage to the instrument, do not attempt to measure voltages that might exceed 1500VDC or peak AC.

4. Connect test leads to device or circuit being measured.
5. Turn on power to device or circuit being measured. Voltage value will appear on Digital Display along with the voltage polarity.
6. Turn off power to device or circuit being tested and discharge all capacitors before disconnecting test leads from device or circuit being tested.

AC Voltage

1. Connect red test lead to V-Ω Input Connector and black test lead to COM Input Connector.
2. Set Function/Range Switch to desired VAC position. If magnitude of voltage is not know, set switch to highest range and reduce until satisfactory reading is obtained.
3. Turn off power to device or circuit being tested and discharge all capacitors.

> **WARNING**
> To avoid electrical shock hazard and/or damage to the instrument, do not attempt to measure voltage that might exceed 1000VRMS or 1500V peaks.

4. Connect test leads to device or circuit being measured.
5. Turn on power to device or circuit being measured. Voltage will appear on Digital Display.
6. Turn off power to device or circuit being tested and discharge all capacitors before disconnecting test leads from device or circuit tested.

AC Conversion Process

Understanding the AC conversion process in the multimeter will help the user to more fully utilize its measurement capability.

The AC converter used in the HD100, HD110, and HD110T models is "average-responding." An RMS value is determined by first rectifying and filtering the signal to obtain the average value. The average value is then scaled upward by a factor of 1.11 to obtain the RMS value. The scaling factor of 1.11 is accurate when measuring sinusoidal waveforms as follows:

$$\text{VRMS} = \frac{\text{Vavg}\,\pi}{2\sqrt{2}} = 1.11\ \text{Vavg}$$

In measuring nonsinusoidal waveforms, however, significant errors can be introduced because of different scaling factors relating average to RMS values. Rough correction factors can be sometimes calculated for standard waveforms that are free from significant noise and distortion but accurate measurements of complex waveforms can be difficult to achieve.

RMS values of nonsinusoidal signals can be measured directly and more accurately with the HD 130B which features a "True-RMS responding" converter. True-RMS response can be particularly useful in measuring complex or noisy signals for which even rough correction factors cannot be easily computed.

Converters of all types are limited by their frequency response and input dynamic range. Bandwidth defines the frequency range in which the conversion accuracy is within 3dB. The bandwidth of the HD130B is 100kHz. Measurements of complex signals will not be affected by converter bandwidth limitations unless there are significant harmonic components beyond 100kHz.

Crest factor is a measure of the input dynamic range of a True-RMS responding converter. It expresses the capability of the converter to handle a signal that has large peak values compared to its RMS value without saturating the converter circuitry and degrading the specified accuracy.

For the HD130B crest factor is defined and the ratio of the peak voltage to the RMS (AC coupled) voltage.

$$\text{Crest Factor} = \frac{\text{V peak}}{\text{VRMS}}$$

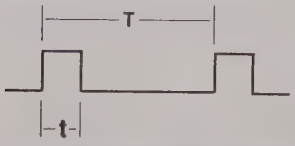
Crest Factor for an AC coupled pulse train is follows:

$$\text{Crest Factor} = \frac{1\text{-}x}{y}$$

where

$$x = \frac{t}{T}$$

$$y = \sqrt{x\text{-}x^2}$$



The HD130B is capable of accurately measuring signals with a crest factor from 1.0 to 5.0 on each voltage scale depending on the signal's value RMS. At full-scale (1999 counts), signals with crest factor between 1.0 and 1.5 can be measured. Signals with a crest factor of 1.0 include a square wave

or pure DC (peak voltage equals RMS voltage). An undistorted sine wave signal (crest factor = 1.414) can also be measured at full-scale.

At half scale (1000 counts), signals with crest factor between 1.0 and 3.0 can be measured without performance degradation. At or below 600 counts, signals with crest factors up to 5.0 can be measured. If the crest factor is not known, it can be determined by measuring the peak voltage with an oscilloscope and dividing by the RMS voltage measured by the multimeter. The crest factors and corresponding display readings for some typical waveforms are shown in Figure 3.

Total RMS Measurements

The HD130B permits measurement of the True-RMS value of the AC component of a signal. Sometimes, it is useful to be able to find the value of the AC and the DC components of the signal (such as measuring the power outputs of switching power supplies). To accomplish this:

1. Set the HD130B to the right VDC range, measure the DC component and record the result;

2. Set the HD130B to the right VAC range, measure the AC RMS component, record the result;

3. Figure the True-RMS value by the following formula:

$$\text{True-RMS} = \sqrt{(\text{AC RMS Component})^2 + (\text{DC Component})^2}$$

Current Measurements

DC Current

1. Connect red test lead to the A Input Connector for current measurements up to two amperes. For current measurements to ten amperes, using models with ten ampere capability, connect red test lead to the 10A Input Connector. Connect black test lead to COM Input Connector.
2. Set Function/Range Switch to desired DCA position. If the magnitude of current is not known, set switch to highest range and reduce setting until satisfactory reading is obtained. When the 10A Input Connector is used, the Function/Range Switch should be placed in the 20 m/10A position.
3. Turn off power to device or circuit being tested and discharge all capacitors.
4. Open circuit in which current is to be measured. Securely connect test leads in series with the load in which current is to be measured.
5. Turn on power to circuit being tested.
6. Read current value on Digital Display.
7. Turn off all power to circuit being tested and discharge all capacitors.
8. Disconnect test leads from circuit and reconnect circuit that was being tested.

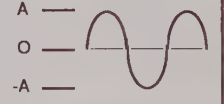
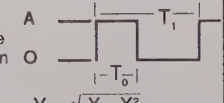
Meter Display Reading			
Input Waveform	HD130B AC True-RMS	HD100, HD110, HD110T Avg Responding	True-RMS (AC+DC) Total RMS = $\sqrt{AC^2+DC^2}$
Sine 	0.707A CF = 1.414	0.707A	0.707A CF = 1.414
Square	1.000A CF = 1.000	1.111A	1.000A CF = 1.000
Triangle	0.577A CF = 1.733	0.555A	0.577A CF = 1.733
Full Wave Rectified Sine	0.308A CF = 2.067	0.298A	0.707A CF = 1.414
Square	0.386A CF = 1.768	0.389A	0.500A CF= 2.000
50% Duty Cycle Pulse Train $T_0 = T_1$	0.500A CF = 1.000	0.555A	0.707A CF = 1.414
Variable Duty Cycle Pulse Train  $X = T_0/T_1$ $Y = \sqrt{X - X^2}$	AY $CF = \frac{1-x}{Y}$	1.111 AY	$A\sqrt{X}$ $CF = \frac{1}{\sqrt{X}}$

Figure 3. Typical Input Waveforms and Meter Readings and Crest Factors (CF)

AC Current

1. Connect red test lead to A Input Connector for measurements up to two amperes. For current measurements to ten amperes, using models with ten ampere capability, connect red test lead to 10A Input Connector. Connect black test lead to COM Input Connector.
2. Set Function/Range Switch to desired ACA position. If the magnitude of current is not known, set switch to highest range and reduce setting until satisfactory reading is obtained. When the 10A Input Connector is used, the Function/Range Switch should be placed in the 20m/10A position.
3. Turn off power to device or circuit being tested and discharge all capacitors.
4. Open circuit in which current is to be measured. Securely connect test leads in series with the load in which the current is to be measured.
5. Turn on power to circuit being tested.
6. Read current value on Digital Display.
7. Turn off all power to circuit being tested and discharge all capacitors.
8. Disconnect test leads from circuit and reconnect circuit that was being tested.

Resistance Measurements

All resistance ranges on the Multimeter are low-power ohms which allow accurate measurements of in-circuit resistance. (Use Diode Test Function for checking diode and other semiconductor junctions.)

1. Connect red test lead to V•Ω Input Connector and black test lead to COM Input Connector.
2. Set Function/Range Switch to desired Ω position. If magnitude of resistance is not known, set switch to highest range and reduce until satisfactory reading is obtained.
3. If the resistance being measured is connected to a circuit, turn off power to circuit being tested and discharge all capacitors.
4. Connect test leads to circuit being measured. When measuring high resistance be careful not to contact adjacent points, even if insulated, because some insulators have a relatively low insulation resistance, which may affect the resulting measurement.
5. Read resistance value on Digital Display. If a high resistance value is shunted by a large value of capacitance, allow Digital Display to stabilize.

Diode and Transistor Test Measurements

The special diode test function allows accurate measurements of forward voltage drops across diodes and transistor junctions. A constant-current source forces 2mA of current into the semiconductor junction under test, which results in the voltage drop being displayed on the Digital Display. This function also permits measurement of in-circuit semiconductor junctions with as

little as 500Ω in parallel with the transistor or diode. The limited current produced by the instrument in the Diode Test Function minimizes the possibility of damage to low-power semiconductor junctions, a common problem when using many analog meters.

Diode Tests

To perform diode test measurements, use the following procedure:

1. Connect the red test lead to the V•Ω Input Connector and the black test lead to the COM Input Connector.
2. Set Function/Range Switch to the Diode Test (—|◄—) position.
3. If the semiconductor junction being measured is connected to a circuit, turn off power to the circuit being tested and discharge all capacitors.
4. Connect test leads to device.
5. Read forward voltage drop on Digital Display.
   If the Digital Display reads OL, reverse the lead connections. The placement of the leads when the forward voltage is displayed (normally 600mV to 900mV) indicates the orientation of the diode. The red lead is then connected to the anode and the black lead is connected to the cathode as shown in Figure 4.

If OL is displayed with both lead connections, the junction is open.

Figure 4. Placement of Leads in Respect to Anode and Cathode

If a low reading (less than 1V) is obtained with both lead connections, the junction is shorted internally or (if the junction is measured in a circuit) is shunted by a resistance less than 500 ohms. In the latter case the junction must be disconnected from the circuit in order to verify its operation.

Transistor Junction Tests

Transistors can be tested in the same manner as diodes by checking the two diode junctions formed between the base and emitter and the base and collector of the transistor. Figure 5 shows the orientation of these effective diode junctions for PNP and NPN transistors. Measurements between the collector and emitter should also be made to determine if a short is present.

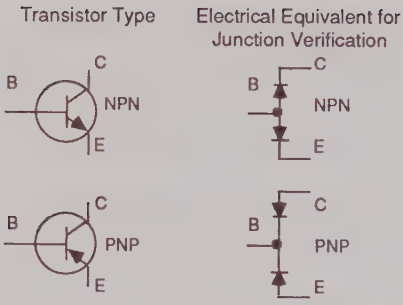


Figure 5. Orientation of Effective Diode Junctions for PNP and NPN Transistors

Transistor Beta Test

With a simple test fixture the Diode Test Function can be used to determine the DC current gain (beta) of a transistor. Beta is measured using a DC collector-to-emitter voltage (Vce) of about 1V and a collector current (Ic) of about 2mA.

The transistor beta test setup is shown in Figure 6 for an NPN transistor. For PNP transistors, the connections to the Multimeter should be reversed.

$$\text{Beta} = \frac{2000}{\text{Display Change in Digits}}$$

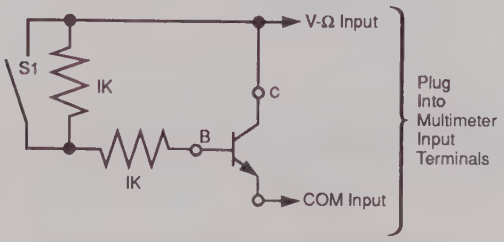


Figure 6. Test Fixture for Beta Measurements

To determine transistor beta, use the following procedure:

1. With all the connections made as shown in Figure 6 and with switch S1 open, record the displayed reading (ignore decimal point).

NOTE

If an overload indication is obtained, reverse the connections to the Multimeter.

If an overload indication is obtained regardless of meter orientation, or if a reading less than 0.200 is obtained, the transistor is probably defective.

2. Close switch S1 and record the new displayed reading (ignore decimal point).
3. Divide 2000 by the difference in digits between the reading obtained in Steps 1 and 2. The resulting number is the transistor DC beta.

Continuity and Capacitor Checks

Before the development of Digital Multimeters by Beckman Industrial Corporation, quick continuity checks using a digital multimeter were not possible. Now, with the Insta-Ohms Quick Continuity Indicator, they can be done just as quickly and as easily as with an analog meter. This feature is particularly useful in circuit and cable tracing, but also may be used for troubleshooting small-value capacitors.

Continuity Checks

1. Place Function/Range Switch in any Ω range.
2. Connect red test lead to the V•Ω connector and the black test lead to the COM connector. With the test leads separated or measuring and out-of-range resistance, the Digital Display will indicate OL, Figure 7.
3. Place one test lead probe at one end of cable or circuit to be tested. Use the other test lead to trace the circuit or cable until the circuit is complete. When continuity is established, an Ω symbol will appear in the upper left-hand corner of the Digital Display, Figure 8. If contact in the cable or circuit is maintained long enough (about 1/4 of a second) the OL will disappear and the resistance value of the cable or circuit will appear next to the Ω symbol, Figure 9.

NOTE

The Insta-Ohms Quick Continuity Indicator quickly identifies completed circuit paths. The trigger point is approximately two to five times the maximum resistance measurable on the selected range.

Capacitor Checks

The Insta-Ohms Quick Continuity Indicator can be used to rough check capacitors with a value greater than or equal to 0.01μF. This feature can be a great aid in troubleshooting circuits in which an open or shorted bypass capacitor is suspected. Use the following procedure to check capacitors:

1. Place Function/Range Switch in 20 MΩ range position.
2. Connect red test lead to V-Ω connector and the black test lead to the COM connector. With the test leads separated, the Digital Display will indicate OL, Figure 7.
3. Discharge the capacitor to be checked by briefly shorting the ends together.
4. Place red test lead probe at one end of capacitor. Place the black test lead at other end of capacitor.

Figure 7. Overload Symbol

Figure 8. Insta-Ohms Quick Continuity Indicator Symbol (Ω)

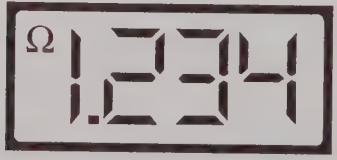


Figure 9. Insta-Ohms Quick Continuity Indicator Symbol (Ω) & Resistance Value

NOTE

Do not touch capacitor leads or test probe ends during capacitor check because proper operation of Insta-Ohms feature could be affected.

5. If the Insta-Ohms symbol (Ω) appears briefly and disappears, the capacitor is accepting a charge.

Mylar Capacitors

If the Insta-Ohms symbol does not appear, the capacitor is probably open. If a low resistance value appears, the capacitor is probably shorted.

Electrolytic and Tantalum Capacitors

A good capacitor will show a reading that rises steadily from 0.00Ω to infinity (OL). This reading could stabilize at a very high value (MΩ), depending on the size and quality of the capacitor. If the reading stabilizes at a low value, the capacitor is probably bad.

NOTE

Insta-Ohms can only be used to check capacitors with a value of 0.01μF or greater.

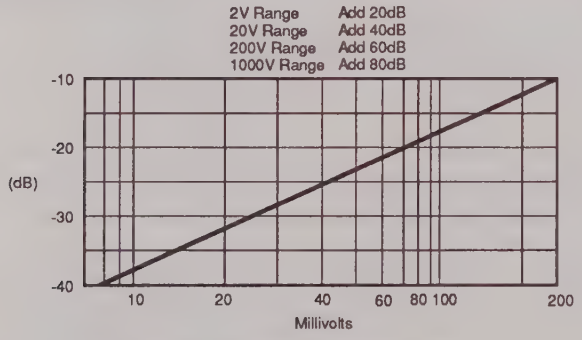


Figure 10. Decibel Conversion Chart

Decibel Measurements

In addition to its normal functions, the Multimeter can be used to measure decibels. The value obtained from this measurement can be used to indicate the gain and accuracy of electronic devices. The decibel (dB) is the logarithm of the ratio of two electrical signals; usually a certain amount of power across a fixed resistance is used as a reference and denoted as 0 (zero) decibels. In Figure 10, 0dB is defined as 1 milliwatt being dissipated in a 600Ω lead. Use the procedure in Section IV, page 20, AC Voltage, to determine AC voltage and the graph of Figure 10 to determine decibel value.

Temperature Measurement (HD 110T Only)

The temperature function of the multimeter is designed for use with an industry-standard type K thermocouple having a miniature or subminiature input connector. Use the following procedure to measure temperature.

1. Disconnect the test leads from the multimeter.
2. Insert type K thermocouple into the input connector at the top of the multimeter, above the LCD.
3. Place the Function/Range Switch in the T/200 μ position.
4. Place the thermocouple probe in the area to be measured and read the meter in degrees.

NOTE

Thermocouple plug must be removed from the meter for normal voltage, current, and resistance readings.

Switching Between Celsius and Fahrenheit Temperature Modes

The HD110T is shipped from the factory set for the Fahrenheit mode. The simple procedure described below permits switching between Fahrenheit and Celsius modes. Either mode may be selected without recalibration.

1. Remove the back cover by removing the four screws and then lifting the cover.
2. Locate jumper connector JX on the input circuit board. Figure 11.
3. Place the jumper on the appropriate pins: 1 and 2 for Celsius; or 5 and 6 for Fahrenheit.
4. Reassemble the multimeter.

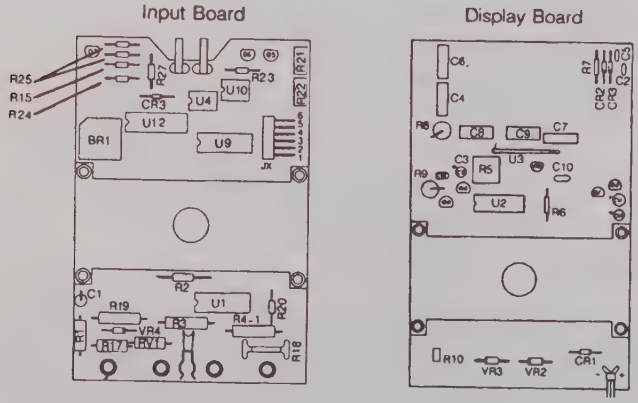


Figure 11. Components Locator for HD110T

Section V Maintenance

This section describes maintenance procedures, calibration, and troubleshooting. In addition, a general statement on service policy is included. Any questions regarding warranty repair or instrument servicing should be directed to Beckman Industrial Corporation or to a Service Center (see Section VII, page 42 for addresses).

Troubleshooting

Except for the replacement of the battery or fuse, repair of the multimeter should be performed only by a Factory Authorized Service Center or by other qualified instrument service personnel.

CAUTION

The CMOS multiprocessor chip U4 is subject to damage created by electrostatic discharge. This component should be handled only by qualified personnel equipped with antistatic grounding devices.

If the multimeter is not performing properly, take the following steps before returning it for repair.

1. Check the battery and fuse connections.
2. Check that the Function/Range Switch is in the correct position for the parameter and value range being measured, and that the measurement value is within the capability of the instrument.
3. Review and comply with the operating instructions contained in Section IV of this manual.
4. Check test leads for breaks or cracks. Ensure that test leads are inserted fully into the connectors.
5. Check to see that the ambient environment in which the instrument is being used is within specifications given in Section II of this instruction manual.
6. If the decimal point in the Digital Display is blinking, the battery is probably low. Replace the battery, using procedure in Section V.
7. If the Digital Display is blank with the unit turned on, the battery is probably dead. Replace the battery, using procedure in Section V.
8. If operation is normal in all functions and ranges except AC and DC current, the fuse is probably blown. Replace fuse, using procedure in Section V.

If the preceding steps do not remedy the problem, refer to the following pages for WARRANTY REPLACEMENT and NONWARRANTY REPAIRS.

Factory Service

The warranty statement for the Heavy Duty Series Multimeters appears at the front of this manual. Read it carefully before requesting warranty repairs.

Any Heavy Duty Series multimeter claimed to be defective should be returned to Beckman Industrial Corp., with a $3.00 handling fee in the continental U.S.A. and $12.00 elsewhere.* Follow the instructions below and in Section VII.

Warranty repair will be made typically within two (2) working days after receipt of defective unit.

Nonwarranty Repairs

Any out-of-warranty meter that is defective, but repairable, can be repaired by an Authorized Service Center or by Beckman Industrial Corp. See Section VII, page 42 The repaired unit carries a three (3) month warranty. Contact any Authorized Service Center for their current nonwarranty repair rates. The standard charge for repair at the Factory Service Center is $50.00.* Be sure to include (a) the specified payment or (b) a purchase order specifically authorizing repair and indicating the correct fee or the Multimeter will be returned to sender C.O.D.

Shipping Instructions

Instruments returned for calibration or repair should be shipped with the following information or items: company name, your name, address, telephone number, proof of purchase (for warranty repairs), a description of the problem encountered or service required, and the appropriate service charge.

*Prices subject to change without notice.

Service charges should be remitted in the form of a check, money order or purchase order made payable to Beckman Industrial Corp.

The multimeter should be shipped with transportation charges prepaid to the appropriate address in Section VII (see page 41).

The multimeter will be returned with transportation charges paid by Beckman Industrial Corp.

Maintenance Procedures

Regular operator maintenance of the Multimeters consists of: cleaning case and window, battery replacement, and fuse replacement. All other repairs should be performed by a Factory Authorized Service Center or other qualified instrument service personnel.

Cleaning Case and Window

CAUTION

Do not use aromatic hydrocarbons or chlorinated solvents for cleaning. These chemicals will react with plastics used in construction of case.

The case is made of an advanced generation plastic which resists damage from many chemical solvents including gasoline. The front panel and case should be cleaned with a mild solution of detergent and water. Apply sparingly with a soft cloth and allow to dry completely before using.

Battery Replacement

WARNING

To prevent electrical shock hazard, turn off Multimeter and disconnect test leads before removing back cover.

1. After disconnecting test leads and turning off Multimeter, remove back cover by removing the four rear screws, and then lift off back cover.

CAUTION

Failure to turn off the instrument before installing the battery could result in damage to the battery if it is connected to the battery terminal incorrectly.

2. The battery is located in the front part of the case as shown in Figure 12, page 34. Disconnect battery from instrument and replace with a standard 9V transistor battery.
3. Replace back cover and secure with four screws, taking care to seat O-ring seal uniformly.

Fuse Replacement

WARNING

To prevent electrical shock hazard, turn off Multimeter and disconnect test leads before removing back cover.

1. Disconnect leads, turn off meter, remove four back cover screws, remove cover.
2. The 2A fuse is located next to the battery, between the A and COM input jacks. Remove the fuse by pulling the ribbon.
3. Replace center of ribbon across the fuse opening and press new fuse into place. Be sure ribbon is between fuse clips, not caught on the clips.

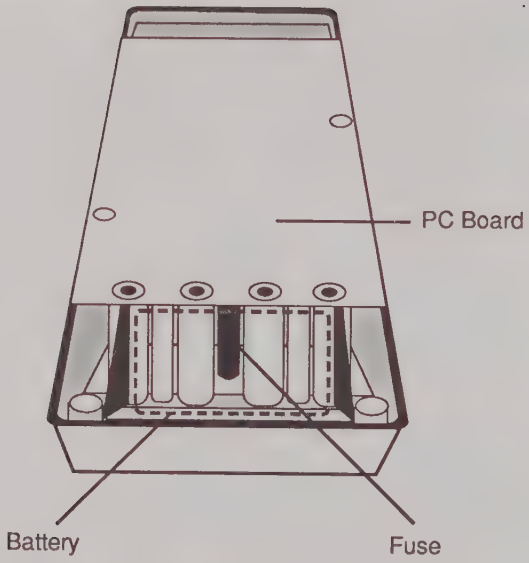


Figure 12. Multimeter, Back Cover Removed

WARNING
To prevent fire, use Type 2A/600V and Type KTK or KLK15A/600V fuses only. The 10A fuse clips must be insulated from battery. Check condition of battery-fuse insulator and replace if damaged.

4. Replace back cover and secure with four screws.

WARNING
Do not operate Multimeter with back cover removed (except during calibration).

Calibration

To maintain the specifications described in Section II of this instruction manual, we recommend that the multimeter be calibrated once each year and/or after it is repaired. For information regarding calibration procedures, please refer to the Heavy Duty Series Service Manual.

Service Manual

A complete service manual is available from Beckman Industrial Corp., for those users who desire to service their own multimeters. To obtain a copy of this manual, send $15.00* (postage and handling) in the form of a check, money order, or a purchase order made payable to Beckman Industrial Corp. See shipping address in Section VII.

Multimeter Storage

WARNING

If Multimeter is to be stored at temperatures above 122°F (50°C), remove battery.

*Prices subject to change without notice.

Section VI Accessories

Accessory Descriptions

This section provides a description of the Heavy Duty Series Multimeter accessories that are available from Beckman Industrial Corporation.

Vinyl Carrying Case (VC-201)

The vinyl carrying case is constructed of durable, padded vinyl and will accommodate any Heavy Duty Series Multimeter Mode. The case has room for the multimeter, operator's manual, and the TL-245 Probe Set without adding any unnecessary bulk. The back of the case has a handy belt loop.

Deluxe Carrying Case (DC-205)

Handsome, yet rugged, this case offers maximum protection for any Heavy Duty Series Multimeter and is designed to permit in-case operation. Constructed of rigid, leather-grained vinyl, the deluxe case has inside compartments for storing the multimeter, test lead set, and the operator's manual.

Deluxe Carrying Case (DC-207)

Tough and attractive, this case offers maximum protection for any Heavy Duty Series Multimeter and is designed to permit in-case operation. Constructed of rigid, leather-grained vinyl, the deluxe case has inside compartments for storing the instrument, test lead set, the operator's manual, and an extra compartment for a current clamp or small tools.

High Voltage Probe (HV-231-22)

The HV-231-22 High Voltage Probe extends the DC voltage measurement capability of any Heavy Duty Series Multimeter to 50kV. This accessory is essential for television and CRT terminal service where second anode voltages must be measured. This probe contains a precision 1000:1 resistor divider that scales high voltages down to a level that the multimeter can handle safely. The high input impedance of the probe minimizes circuit loading and assures accurate measurements.

HIGH VOLTAGE PROBE SPECIFICATIONS

Voltage Range:	40kVDC or VAC peak up to 300Hz
Input Resistance:	1000MΩ
Input Impedance Compatibility:	22MΩ or less
Division Ratio:	1000 to 1
Accuracy:	DC ±2%, AC ±3%
Temperature Coefficient:	less than 200ppm/°C

OPERATION WITH HV-231-22 HIGH VOLTAGE PROBE

Warning

The HV-231-22 High Voltage Probe is used to measure potentially lethal voltages. Always disconnect power and discharge voltage source before connecting or disconnecting the High Voltage Probe.

When the High Voltage Probe is used, the probe replaces the standard test leads. The probe is connected to the multimeter in the same manner as the TL-245 Probe Set leads, and measurements are made as described in Section IV except that, because the probe is a precision 1000:1 divider, the Digital Display readings are in kilovolts. A measured value of 50kV will therefore read +50.0 with the Function/Range Switch in the 200VDC position.

RF Probe (RF-221-22)

The peak detecting RF-221-22 RF Probe extends the VAC measuring capability of Heavy Duty Series Multimeters to 200MHz. It provides VDC calibrated to equal the RMS value of a sine wave.

RF-221-22 RF PROBE SPECIFICATIONS

Frequency Range:	2kHz to 200MHz
Accuracy:	±(1% input + 50mV), from 2kHz to 10MHz
	±1dB from 10MHz to 10MHz
	±6dB from 100MHz to 200MHz
Maximum Reading:	25VRMS
Response:	Peak sensing, RMS calibrated
Input Impedance:	1.5MΩ in parallel with 7pF
Overvoltage Protection:	130VRMS at 60Hz or 250VDC

OPERATION WITH RF-221-22 PROBE

The RF-221-22 RF Probe is connected to the meter like the TL-245 Probe Set leads. Measurements are made as described in Section IV. Use appropriate VDC range from 200mV to 200V and read voltage signal directly in VRMS.

AC Current Clamp (CT-231)

The CT-231 AC Current Clamp extends the AC current measurement capability of any Heavy Duty Series Multimeter to 150A without breaking the circuit under test. The 1000:1 current transformer allows direct reading in amperes when used with the 200mA AC current range of the multimeter.

CT-231 CURRENT CLAMP SPECIFICATIONS

Range:	10A to 150A RMS AC
Frequency Range:	30Hz to 1kHz
Accuracy:	±3% (50Hz to 1kHz)
Division Ratio:	1000:1
Circuit-to-Ground Voltage:	1000 VRMS maximum
Maximum Conductor Size:	0.45 inch (11.4 mm)

OPERATION WITH CT-231 AC CURRENT CLAMP

The CT-231 AC Current Clamp is connected to the A and COM Input Connectors of the multimeter in place of the TL-245 Probe Set leads. The jaws of the current clamp are placed around one of the current carrying conductors. In the 200mA ACA position, current is read directly in amperes.

AC Current Clamp (CT-232)

The CT-232 AC Current Clamp extends the AC current measurement capability of any Heavy Duty Series Multimeter to 1000A by use of a 1000:1 current transformer. The clamp-on design permits AC current measurements without breaking the circuit under test.

CT-232 AC CURRENT CLAMP SPECIFICATIONS

Range:	10A to 1000A RMS AC
Frequency Range:	30Hz to 1kHz
Accuracy:	±2% (30Hz to 1kHz)
Division Ratio:	1000:1
Circuit-to-Ground Voltage:	1000VRMS maximum
Maximum Conductor Size:	2.125 inches (54mm)

OPERATION WITH CT-232 AC CURRENT CLAMP

The CT-232 AC Current Clamp is connected to the A and COM Input Connectors of the multimeter in place of the TL-245 Probe Set leads. The jaws of the current clamp are placed around one of the current carrying conductors. With the multimeter in the 2A ACA position, the displayed value is multiplied by 1000 to obtain measured current in amperes.

AC Current Clamp (CT-234A)

The CT-234A AC Current Clamp extends the AC current measurement capability of any Multimeter to 400A without breaking the circuit under test. The 1000:1 current transformer allows direct reading in amperes when used with the 200mA AC current range of the multimeter.

CT-234A AC CURRENT CLAMP SPECIFICATONS

Range:	4 to 400A RMS AC
Frequency Range:	48Hz to 1kHz
Accuracy:	±3% (50 Hz to 1 kHz)
Division Ratio:	1000:1
Circuit-to-Ground Voltage:	1000 VRMS maximum
Maximum Conductor Size:	1.375 inches (34.9mm) diameter or 2.5 inches (63.5mm) wide

OPERATION WITH CT-234 AC CURRENT CLAMP

The CT-234A AC Current Clamp is connected to the A and COM Input Connectors of the multimeter in place of the TL-245 Probe Set leads. The jaws of the current clamp are placed around one of the current carrying conductors. With the multimeter in the 200mA ACA position, current is read directly in amperes.

Test Lead Accessory Kit (DL-243)

The specially designed DL-243 Test Lead Kit comes in a handy vinyl case. The kit includes: alligator clips and banana tips. All tips will plug into the test lead set provided with the kit.

Deluxe Test Lead Accessory Kit (DL-248)

This specially designed Deluxe Test Lead Kit includes a complete assortment of probe tips for every measurement application. The kit includes the following pairs of tips: alligator clips, banana tips, needle tips, medium-size spring-loaded hooks, and large-size spring-loaded hooks. All items are packaged in a deluxe three-compartment cordura nylon fabric case with Velcro closures.

Temperature/Voltage Converter (TC-253)

The TC-253 converts type K thermocouple voltages for use with any Heavy Duty Series DMM. It interfaces between the DMM and any type K thermocouple or probe using a standard type K miniature or subminiature connector. The display is switch-selectable to read in degrees C or F.

TEMPERATURE/VOLTAGE CONVERTER SPECIFICATIONS

Accuracy: *22°C ±3°C Ambient

TEMPERATURE RANGE		ACCURACY
°C	°F	
-50° to -10°	-58° to +14°	1.2% rdg. + 2.5°C or 4.5°F
-10° to +200°	+14° to +392°	0.5% rdg. + 1.5°C or 2.7°F
+200° to +500°	+392° to +932°	0.7% rdg. + 1.5°C or 2.7°F
+500° to +900°	+932° to +1652°	1.4% rdg. + 1.5°C or 2.7°F

*For total measurement accuracy, include error due to meter and thermocouple.

OPERATION WITH TC-253 TEMPERATURE/VOLTAGE CONVERTER

1. Plug TC-253 into V-Ω and COM inputs of multimeter.
2. Plug in type K thermocouple connecter at input, switch to °C or °F. Type K Thermocouple accessories, TP-254 (Probe with four foot lead) and TP-255 (four foot leads) are available for use with this accessory.
3. Select 200mVDC range (if "OL," select 2VDC range) and read display in degrees.

Fuse Pack (FP-260)

Each pack contains four 2A/600V fuses for the Heavy Duty Series Digital Multimeters.

Section VII Service Centers

Factory Service

Read the warranty before requesting warranty or non-warranty repairs.

Shipping Instructions

A multimeter returned for calibration or repair should be shipped with the following: your company name (if applicable), your name, address, telephone number, proof of purchase (for warranty repairs), a description of the problem encountered or service required, and the $3 handling charge in the continental USA, $12 from elsewhere.

Remit shipping/handling charges in the form of a check or money order, payable to Beckman Industrial Corp. Ship the multimeter in a sturdy box with shipping charges prepaid to the following address:

For U.S.A.:	For U.K.:	For Canada:
Beckman Industrial Corp.	Beckman Industrial Ltd.	(See list of
550 S. Harbor Blvd.	Queensway, Glenrothes, Fife	service centers,
La Habra, CA 90631	Scotland KY7-5PU, United Kingdom	pages 42-45)
Tel: (213) 690-7255	Tel: 0592 753811	

ATTN: Instrument Repair / Service

The multimeter will be returned with the shipping charge paid by Beckman Industrial Corp. For questions in North America, contact the Instrument Repair & Service Dept. at (213) 690-7255.

Service & Shipping Instructions for Other Nations

Contact your local Beckman Industrial Corp. dealer or distributor where the multimeter was purchased or refer to the list on beginning page 42.

Service Centers

Angola
Technidata Ltd.
P.O. Box 1619
Rua Reverendo Agostinho Pedro
Neto 21-21A
LUANDA
Tel: 32025/32309, Tlx: 3019

Austria
Lipschitz & Co. GmbH
Nobilegasse 50
1150 WIEN
Tel: 0222-952577, Tlx: 133378

Bahrain
Al-Jishi Corporation
P.O. Box 619
Al-Khalifa Road
MANAMA
Tel: 253297, Tlx: 8371

Belgium
Mecotronic pvba
Nieuwelaan 58
1860 MEISE
Tel: 02-2690748, Tlx: 65602

Canada
BCS Instruments
980 Alness St. Unit 6
Downsview
ONTARIO M3J252
Tel:416-661-5585

Kingsway
4238 91-A Street
Edmonton
ALBERTA T6E5VZ
Tel: 403-463-5264

Miller Instruments LTD.
55 East 5th Avenue
Vancover
BRITISH COLUMBIA V5T 1G7

COMECON (Bulgaria, Poland, Czechoslovakia, DDR, Romania)
C.A.T. Electro Ltd.
Dalriada House, South Street,
Bo'ness, West Lothian,
EH51 9HA
United Kingdom
Tel: (0506) 826305, Tlx: 727563

Denmark
ITT Instruments A/S
29 Naverland
2600 Glostrup
Tel: 02-451822, Tlx: 33355

Egypt
Etico Scientific
3 Ahmed Heshmat Street
P.O. Box 1653
Zamalek
CAIRO
Tel: 403041/407733, Tlx: 93382

Finland
Dualtek OY
P.O. Box 14
Espoo 02321
Tel: 8019911, Tlx: 123369

France
Beckman Industrial Sarl
1Bis Ave du Coteau
F93220 GAGNY
Tel: (01) 43027606, Tlx: 212971

Germany
Beckman Components GmbH
Frankfurter Ring 115
8000 MÜNCHEN 40
Tel: 089/38871, Tlx: 5216197

Greece
General Electronics Ltd.
209 Thivon Street
184 54 Nikaia
PIRAEUS - 77
Tel: 01-4922068, Tlx: 212949

Hungary
Dahms Elektronik
Pilgramgasse 11
A-1050 WIEN
Tel: 0222-543321, Tlx: 134583

Iceland
Karl Asgeirsson
P.O. Box 406
121 REYKJAVIK
Tel: 91622884
Tlx: 91671452

Iran
Zeefax Ltd.
College House
Wrights Lane, Kensington
London W8 5SH
UNITED KINGDOM

Ireland
Neltronics Ltd.
John F. Kennedy Road
Naas Road
DUBLIN 12
EIRE
Tel: 501845
Tlx: 24837

Israel
Elina Ltd.
35 Jabotinsky Road
P.O. Box 4130
52141 RAMAT-GAN
Tel: (03)7514129, Tlx: 33486

Racom Electronics LTD.
P.O. Box 21120
TEL AVIV 61210
Tel: 03491922 Tlx: 33808

Italy
Beckman Industrial Srl
via Arese 11
20159 MILANO
Tel: (02) 688 8951, Tlx: 330484

Jordan
Scientific & Medical
Supplies Co.
P.O. Box 1387
AMMAN
Tel: 24902, Tlx: 21456

Kuwait
AZ Trading Co.
P.O. Box 25752
Jaber Al-Mubarak Street
SAFAT
Tel: 442208, Tlx: 22707

Lebanon
Elco Ltd.
P.O. Box 136
ANTELIAS
Tel: 894420/894699, Tlx: 22867

Malta
Fabian Enterprises
20, Msida Road
GZIRA
Tel: 513283, Tlx: 1837

Morocco
Ets H. Dolbeau
Département Electronique
81 Rue Karatchi
CASABLANCA
Tel: 304182, Tlx: 22833

Sicotel AS
Complexe Commercial
De Habous
Tour C 2ème Etage
Ave Des Forces Armees Royales
CASABLANCA
Tel: 212312270, Tlx: 27604M

Namibia
Siemens
P.O. Box 23125
WINDHOEK 9000
Tel: 61358, Tlx: 50908-425

Netherlands
Diode B.V.
Meidoornkade 72
AE HOUTEN 3992
Tel: 340391234, Tlx: 47388

Norway
Hellermann Haugerud A/S
Sandakervn 110, OSLO 4
Tel: (02) 156012, Tlx: 18469

Oman
Photocentre
P.O. Box 3115 (Ruwi)
MUSCAT
Tel: 706752
Tlx: 3499

Portugal
Decada Espectral Equipamentos
de Cientificos Sarl
Avda Bombeiros Voluntarios
Lote 102B
Miraflores/Alges
1495 LISBOA
Tel: 4103420
Tlx: 15515

Qatar
Technology
P.O. Box 3549
DOHA
Tel: 321431, Tlx: 4581

Saudi Arabia
Mejdaf Establishment
P.O. Box 2002
RIYADH 11451
Tel: 011-4013206/4055240
Tlx: 202787

South Africa
Bowthorpe Hellermann
Deutsch Ltd.
80 Mimetes Rd,
Denver 2094,
JOHANNESBURG
Tel: 11-616-1960, Tlx: 4-28237

Sweden
Quito Electronics AB
P.O. Box 515
S-145 63 Norsborg
SWEDEN
Tel: 75371765

Switzerland
W. Moor AG
Bahnstrasse 58
8105 Regensdorf
ZURICH
Tel: 8433111
Tlx: 825840

Syria
Far-Tou Representation
Place de l'Etoile
P.O. Box 2657
29 Rue Parlement
DAMASCUS
Tel: 222261, Tlx: 11319

Tanzania
International Services Ltd.
Makunganya Street
P.O. Box 5120
DAR ES SALAAM
Tel: 30778, Tlx: 41312

Tunisia
Tunisie Electronique Sarl
31 Avenue de la Liberté
1002 TUNIS - Belvedere
Tel: 01-280144, Tlx: 13238

Turkey
Turkelek Elektronik Co. Ltd.
Hatay Sokak 8
ANKARA
Tel: 189483, Tlx: 42120

United Arab Emirates
Scientechnic
P.O. Box 325
DUBAI
Tel: 666000, Tlx: 46072

United Kingdom
Beckman Industrial Ltd.
Queensway, Glenrothes, Fife
SCOTLAND KY7-5PU
Tel: 0592 753811, Tlx: 72135

U.K. Sales Office
Beckman Industrial Ltd
43-48 New Street
Birmingham B24LJ
ENGLAND
Tel: 021 643 8899
Tlx: 333 95 76

United States of America
Beckman Industrial Corp.
550 S. Harbor Blvd.
La Habra, CA 90631
Tel: (213) 690-7255 (310) AREA CODE
Tlx: 188790

Beckman Industrial Corp.
510 Heron Drive
Box-Suite 202
Bridgeport, NJ 08014
(609) 467-4220

Yugoslavia
Dahms Elektronik
Wienerstrasse 287
8051 GRAZ - AUSTRIA
Tel: 316-64030, Tlx: 31099

Zimbabwe
BAK Electrical Holdings Ltd.
Kercom
30 Pioneer Street
P.O. Box 2780
HARARE
Tel: 707601, Tlx: 2343

11. Please rate the **Importance** of the following capabilities **on a Multimeter**:

	Importance (Please circle one)		
	Lo	Med	Hi
A. AC True RMS	1	2	3
B. AC + DC True RMS	1	2	3
C. AC Power Measurement	1	2	3
D. dBm (600 ohms)	1	2	3
E. Drop Proof	1	2	3
F. Splash Proof	1	2	3
G. dBV	1	2	3
H. Wire or Cable Test	1	2	3
I. Computer Interface	1	2	3
J. Dual Display	1	2	3
K. Min/Max Record	1	2	3
L. Temperature	1	2	3
M. 24 Hour Average	1	2	3
N. Pulse Width Measurements	1	2	3
O. Totalizer Mode	1	2	3
P. Capacitance Measurements	1	2	3
Q. Duty Cycle Measurements	1	2	3
R. Frequency Counter	1	2	3

12. Are there any comments, suggestions, or products you would like us to build or improve? _____

_____

_____

_____

_____

P/N 1000-0056-00

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PRODUCT REGISTRATION CARD

Please complete and return in 10 days

This card will allow us to notify you in the event of significant product changes or updates, and to understand your future multimeter needs.

Model# _____ Serial# _____

Name _____ Job Title _____

Company _____

Street Address _____

City _____ State _____ Zip _____ Country _____

Phone# (___) _____ Purchase Date _____

1. Condition upon receipt: ☐ Satisfactory ☐ Unsatisfactory (Please Describe)

_____

2. This meter will be **used mostly for**: (Check one only)

___ A. Design
___ B. Research
___ C. Bench Service
___ D. Electronic Field Service
___ E. Electrical Field Service
___ F. Facilities Maintenance
___ G. Production Test
___ H. Production Equipment Maintenance
___ I. Home Use
___ J. Quality Control
___ K. Other _____

3. Please check the **products** or **equipment** that **you test**: (Check all that apply)

___ A. Electrical Power Circuits
___ B. Broadcast Equipment
___ C. Power Generation or Transmission
___ D. Cable TV
___ E. Consumer Electronics
___ F. Computers and Peripherals
___ G. HVAC – Refrigeration
___ H. Office & Business Machines
___ I. Automotive
___ J. Communications Systems & Equipment
___ K. Electrical Machinery
___ L. Components & Subassemblies
___ M. Medical Electronics
___ N. Industrial Controls
___ O. Aircraft, Missiles, Space & Ground Support
___ P. Test, Measurement & Instrument
___ Q. Point of Sale Equipment
___ R. Other _____

☐ Please indicate here the letter of the **product you test most often.**

4. How many employees does your company have worldwide?

___ A. 1 to 19 ___ D. 100 to 249 ___ G. 1000 or more
___ B. 20 to 49 ___ E. 250 to 499
___ C. 50 to 99 ___ F. 500 to 999

5. What end product or service is your company's or division's **primary business**? (Check one only)

___ A. Aerospace
___ B. Airline
___ C. Automotive
___ D. Appliances
___ E. Broadcast or Entertainment
___ F. Business or Office Machines
___ G. Chemical, Plastic or Rubber
___ H. Commercial Building
___ I. Commercial Mobil Radio
___ J. Computers or Peripherals
___ K. Consumer Electronics
___ L. Data Communication
___ M. Education
___ N. Electrical Components
___ O. Electrical Contractor
___ P. Electronic Components
___ Q. Fabricated Metals
___ R. Food, Drug, or Beverage
___ S. Glass, Stone, or Concrete
___ T. HVAC-Refrigeration
___ U. Industrial Machinery
___ V. Marine
___ W. Medical Equipment
___ X. Mining, Mineral Science
___ Y. Petroleum
___ Z. Process or Industrial Controls
___ aa. Rail
___ bb. Research Lab
___ cc. Telecommunication
___ dd. Test Equipment or Instruments
___ ee. Utility, Electrical and/or Gas
___ ff. Utility, Water and/or Sewage
___ gg. Wood or Paper Products
___ hh. Other _____

6. How did you find out about this product? (Check all that apply)

___ A. Print Advertisement (name of publication) _____
___ B. Salesperson
___ C. Catalog (name) _____
___ D. Store Display
___ E. Friend
___ F. Product Flyer
___ G. Trade Show
___ H. Prior Use
___ I. Company Issued
___ J. Suggested by Original Equipment Manufacturer (name) _____
___ K. Other _____

7. Was this meter purchased with personal funds? ☐ Yes ☐ No

8. Where was this meter purchased?

___ A. Electronic Parts Supply House (name) _____
___ B. Electrical Wholesaler (name) _____
___ C. Provided by Company
___ D. Catalog (name) _____
___ E. Other _____
___ F. Don't Know

9. What trade publications or technical magazines do you read most often? ☐ None

1. _____
2. _____
3. _____

10. What product information would you like to receive from us?

___ A. New Product Information
___ B. Product Catalog
___ C. Accessories Catalog
___ D. None
___ E. Other _____

(over ➜)

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Beckman Industrial™

An Affiliate of Emerson Electric Co.

Instrumentation Products Division
3883 Ruffin Road
San Diego, CA 92123-9922

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Beckman Industrial Corporation
Instrumentation Products Division
An Affiliate of Emerson Electric Co.
3883 Ruffin Rd., San Diego, CA 92123-1898
(619) 495-3200 FAX: (619) 268-0172 TLX: 249031

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0592 753811 FAX: 0592 756443 TLX: 72135

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